ARIZONA DEPARTMENT
OF
ENVIRONMENTAL QUALITY

Douglas A. Ducey
Governor

Misael Cabrera
Director

via e-mail

October 15, 2017
FPU18-085

Ms. Catherine Jerrard
AFCEC/CIBW
706 Hangar Road
Rome, NY 13441

RE: WAFB – ADEQ comments - *Revised Draft, Soil Vapor Extraction System/Steam Enhanced Extraction System, Operation and Maintenance, 2015 Annual Performance Report, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona*; prepared for Air Force Civil Engineer Center (AFCEC/CIBW), Lackland AFB, TX; prepared by Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec), Phoenix, AZ; document dated August 25, 2017.

Dear Ms. Jerrard:

Arizona Department of Environmental Quality (ADEQ) Federal Projects (FP) personnel and ADEQ contractor UXO Pro, Inc. reviewed the above referenced document. ADEQ's comments are presented below and on following pages.

General Comments

GC 1: The report should provide an explanation or data to support the "optimization" and cycling of eductor skids discussed in Sections 3.1.1, 3.2.1.2.1, and 3.2.3. The mass removal data during the reporting period indicates the maximum mass removal rate was achieved with a sustained, maximum extraction rate. Cycling the educator skids on a daily basis is described as optimal compared to operating all six skids simultaneously to maximize the water extraction rate. However, the mass extraction rates actually decreased with the reduction in pumping and the onset of pressure cycling.

Changes in vapor concentrations associated with pressure cycling are not evident in the data presented. As discussed during BCT meetings during the reporting period, pressure cycling has a very limited technical basis for sustained increases in vapor concentrations of volatile hydrocarbons such as benzene when the majority of the mass remains in the LNAPL phase rather than dissolved in water. The data as presented substantiate this observation suggesting an increased and sustained extraction rate is a more effective strategy.

GC 2: Provide support that a mass balance on water is adequate to assess containment during steam injection, a multi-phase process. As described in a previous ADEQ memo and in discussions during BCT meetings, steam vapors displace liquid water from soil pore space and this displaced water must be accounted for in assessing containment along with natural groundwater flow.

Operational periods occurred when the extraction rate was less than the injection rate and the steam zone was allowed to grow outward for a time beyond perimeter extraction wells. The large pressure gradients associated with this outward growth can mobilize LNAPL outward; however, the subsequent pressure gradients when the extraction rate increased (or steam injection rate decreased) are much, much smaller and unlikely to mobilize the LNAPL back inward leaving the LNAPL stranded around the perimeter of the thermal treatment zone.

Specific Comments

1. Page 2-2, Section 2.1.1, line 371. Delete either vacuum or pressure; the terms are opposite-signed descriptors of the same variable referenced to absolute pressure. The term "vacuum pressure" should also be changed in lines 531 and 550(d).
2. Page 2-9, Section 2.2.1.1, line 519. Include a brief description for the start time of steam injection in the CZ during July 2015 and note this corresponds to the majority of increases in VOC concentration during the second half of 2015.
3. Page 2-12, Table 2-7. Please consider adding a column for the average extraction rate from open wells.
4. Page 2-16, Section 2.2.1.1, line 554. Include similar discussions for O2 and methane as provided for CO2 data presented in Table 2-7. For example, the lowest average O2 concentration observed in an open well during the reporting period (16.7%) was detected at ST012-SVE-01M indicating an increase in aerobic degradation in the vicinity of the well. Methane exceeded 100 %LEL in multiple wells in concert with increases in VOC concentration suggesting heat from SEE increased both volatilization and anaerobic degradation activity.
5. Page 2-22, Section 2.3.2, line 697. "The increases in mass removal are likely due to the initiation and ongoing operation of SEE at the site." Do other explanations exist? If so, include them or make the statement more definitive.
6. Page 3-11, Section 3.2.1.2.1, line 977. Please state that vapor flow rate was not measured from the three individual vertical zones; only for the total vapor flow. As a result, the zones from which non-condensable vapors and steam vapor were extracted are not known and therefore the mass removal rate from individual zones cannot be assessed. The inability to assess mass removal from individual treatment intervals (CZ, UWBZ, and LSZ) hampers performance evaluation.
7. Page 3-13, Section 3.2.1.2.2, line 1015. Please edit the sentence to read, "Graph 3-5 shows the groundwater extraction rate by treatment zone since startup."
8. Page 3-15, Section 3.2.1.2.4. Please provide a discussion and lab reports for any LNAPL samples that were analyzed during the reporting period. The same section of the previous Annual Report states "Beginning the first quarter of 2015, recovered LNAPL will be sampled on a monthly basis…"
9. Page 3-30, Section 3.2.1.3.3. Provide additional peer-reviewed, published support for the benzene calculation method accuracy. The benzene concentration calculation method is interpreted to be qualitative and not uniformly embraced as an accurate method. As stated, variability in the calculated concentrations was observed and attributed to variability in the feedwater concentration and the identified flow measurement errors. In addition, the text should also mention the variability in the analytical results as laboratory data are only accurate to about +/-30% and only reported to two significant digits. As evidenced by the calculation of many negative values, the calculated concentrations are unreliable and cannot be used to support the transition from SEE to EBR. Measures of the benzene concentration in the air stripper influent provide a more consistent and reliable indicator of cleanup progress.
10. Page 3-30, Section 3.2.1.3.3. On the right side of the equation, $C_{formation}$ should be replaced with C_{return}.
11. Page 3-32, Section 3.2.1.4. Include a discussion of the pump intake depths in relation to the water table drawdown in the jar test wells. The depth of the pump is a primary determinant in the recovery of

LNAPL from these wells. For example, a relatively deep pump placement can allow a very large volume of LNAPL to collect at the water table surface with very little LNAPL being extracted by the pump. The MPE well jar testing is qualitative and provides little value in assessing system performance.

12. Table 3-7. Please include the missing data for samples collected from 11/9/2015 through 11/12/2015 that was included in the previously submitted Preliminary analytical results.
13. Page 3-45, Section 3.2.3, line 1309. Please present mass removal extraction benefit outcome data supporting daily educator skid cycling, compared to mass removal extraction operating all skids simultaneously. (Purpose is to explain counter-conventional thought that "maximizing extraction rate maximizes the mass removal rate").
14. Page 3-50, Section 3.3.1.1. Please include a more detailed discussion regarding the reliability of the thermocouples and associated effects on the interpretation of subsurface temperatures. As discussed during BCT meetings during the reporting period, many of the thermocouples utilized to calculate average subsurface zone temperatures were erratic and many readings were unreliable. With respect to progress toward attaining remedial goals, attaining target temperatures is a prerequisite for desired SEE performance but is not an indicator of SEE duration to attain remedial goals.
15. Page 3-53, Section 3.3.1.2. Lines 1483-1484 indicate changes in vapor concentrations associated with pressure cycling are not evident in the data presented. Provide discussion on this inconclusive criterion attainment. As discussed during BCT meetings during the reporting period, pressure cycling has a limited technical basis for sustained increases in vapor concentrations of volatile hydrocarbons such as benzene when the majority of the mass remains in the LNAPL phase rather than dissolved in water. The data as presented substantiate this observation suggesting an increased and sustained extraction rate is a more effective strategy.
16. Page 3-55, Section 3.3.1.3, lines 1532-1535. Please include a discussion regarding the relative effects of pressure cycling on the reported mass removal estimates. The peak LNAPL removal of approximately 13,000 lbs/day is reported for May 2015 and compared to the average LNAPL removal rate of approximately 1,800 lbs/day at the end of the October through December 2015 reporting period. The comparison of these two rates is biased in that the average of 1,800 lbs/day occurred during pressure cycling when, as described in the previous comment, LNAPL mass extraction is not optimal while the May 2015 estimate occurred during sustained steam injection and fluids extraction.
17. Page 3-57, Table 3-11. Please add a row to Table 3-11 providing the "Average Daily Mass Removal as Vapor" using the data from the table. The mass removed as vapor from the wellfield on an average daily basis was 33% higher in the reporting period (2,427 lbs/day) than the average during the previous operations since startup of SEE (1,819 lbs/day).
18. Page 3-58, Table 3-12. Two columns have the identical heading "Q3 2015 Average." Please clarify.
19. Page 3-58, Section 3.3.2.1. 2. Provide support and/or quantitative criteria for using a mass balance on water to assess containment during steam injection. As described in a previous ADEQ memo and in discussions during BCT meetings, steam vapors displace liquid water from soil pore space and this displaced water must be accounted for in assessing containment. In addition, the extensive heterogeneity at the site necessitates a ratio far in excess of one for the extraction rate compared to the injection rate, even after accounting for displaced groundwater and natural groundwater flow. Heterogeneity in the soil permeability and operational well placement may allow uncontained outflows in some portions of the site accompanied by inflows in other areas such that a simplistic mass balance is maintained while containment is not. Further, documented operational periods occurred when the design water mass balance was not maintained and containment was known to be lost.
20. Appendix G. The Appendix is missing lab reports for groundwater samples collected 10/5/2015 through 10/7/2015 and 11/9/2015 through 11/12/2015
21. Appendix L. Please revise the statement to provide a more realistic interpretation of the data. ADEQ does not concur with the statement that the method for calculating benzene concentrations is "successful in providing a qualitative measure of the dissolved phase benzene concentrations at individual MPE

wells sampled." Provide additional peer-reviewed, published support for the benzene calculation method. As stated, variability in the calculated concentrations was observed and attributed to variability in the feedwater concentration and the identified flow measurement errors. In addition, the text should also mention the variability in the analytical results as laboratory data are only accurate to about +/- 30% and only reported to two significant digits. As evidenced by the calculation of many negative values, the calculated concentrations are unreliable and cannot be used to support the transition from SEE to EBR. Measures of the benzene concentration in the air stripper influent provide a more consistent and reliable indicator of cleanup progress.

Closure

ADEQ may add or amend ADEQ comments if evidence to the contrary of our understanding is discovered; if received information is determined to be inaccurate; if any condition was unknown to ADEQ at the time this document was submitted or electronically delivered; if other parties bring valid and proven concerns to our attention; or site conditions are deemed not protective of human health and the environment within the scope of this Department.

Thank you for the opportunity to comment. Should you have any questions regarding this correspondence, please contact me by phone at (602) 771-4121 or e-mail miller.wayne@azdeq.gov.

Sincerely,
Wayne Miller
ADEQ Project Manager, Federal Projects Unit
Remedial Projects Section, Waste Programs Division

cc:	Catherine Jerrard, USAF AFCEC/CIBW	catherine.jerrard@us.af.mil
	Carolyn d'Almeida, U.S. EPA	dAlmeida.Carolyn@epamail.epa.gov
	Ardis Dickey, AFCEC/CIBW	ardis.dickey.ctr@us.af.mil
	Steve Willis, UXO Pro, Inc.	steve@uxopro.com
	ADEQ Reading and Project File	